MICRO-G NEXT 2019 DESIGN CHALLENGES

List of Micro-g NExT 2019 Design Challenges

NASA Microgravity NExT

Sharp Edge Detection and Removal/Covering

Background

The International Space Station (ISS) has many handrails (Reference Figure 1) mounted on its exterior to enable astronauts to get around during Extravehicular Activities (EVA), or spacewalks. These handrails can develop sharp edges due to impacts by Micrometeoroids and Orbital Debris (MMOD). The sharp edges can be dangerous since they have the ability to cut parts of the spacesuit, in particular the gloves. This challenge is multifaceted. First, the astronauts need to be able to detect a sharp edge, which can be difficult when wearing a pressured spacesuit. Then, once located, the astronauts need to remove or cover the sharp edge without creating an additional hazard.

Objective

Design a method for both detecting sharp edges AND removing/or permanently covering sharp edges from an EVA handrail.

Assumptions

- The location of the sharp edge is not visible to the astronaut. It has to be detected by another method.
- The MMOD impact that creates the sharp edge will create a crater no bigger than 1/16" in diameter (Reference Figure 2).
- The sharp edge can appear on either of the three exposed handrail faces (Reference Figure 3). It can appear on any part of the profile (reference Side view in Figure 3).
- The astronaut is stabilized, has 2 free hands and can react small amounts of load.
- The device can have multiple parts that can attach and detach.

Requirements

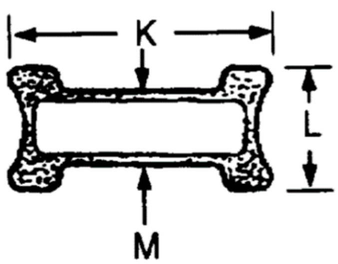
1	The device/s shall be able to detect sharp edges that protrude between .050" - .125" from the surface of the handrail.
2	The device/s shall be able to remove or permanently cover the sharp edge to the greatest extent possible.
3	The structural integrity of the handrail must not be compromised.
4	The creation of Flying Object Debris (FOD) should be minimized.
5	The system can be manual, pneumatic or electrical. If the system is pneumatic or electrical it must meet additional NBL Requirements.
6	The total weight of all parts you provide should be less than 15 lbs.
7	The device/s shall be able to pack within a 12" x 16" x 18" volume.
8	The device and any removable components shall have a tether attachment point 1" in diameter.
9	All tools must be operable with EVA gloved hands (like heavy ski gloves).
10	Tools must not have holes or openings which would allow/cause entrapment of fingers.
11	Tools must be made from the NBL Approved Materials List or a waiver must be granted.
12	Lubricants must be selected from the NBL Approved Lubricant List or a waiver must be granted.
13	There shall be no sharp edges on the tool.
14	Pinch points should be minimized and labeled.
15	Tools shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool.

Test Setup

- Each team will have at least 2 sharp edges to detect and remove.
- A simulated sharp edge will be placed somewhere on one of 3 exposed handrail faces (reference Figure 3).
- The test subject will use your tool to detect the sharp edge.
- Once located, the test subject will then attempt to remove the sharp edge.
- Confirmation the sharp edge has been removed can be done with your detection tool and/or by support divers.

References

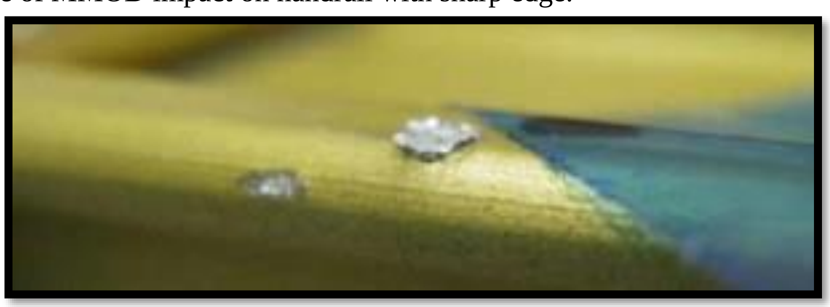
Figure 1 – Picture of ISS EVA Handrail and dimensions.

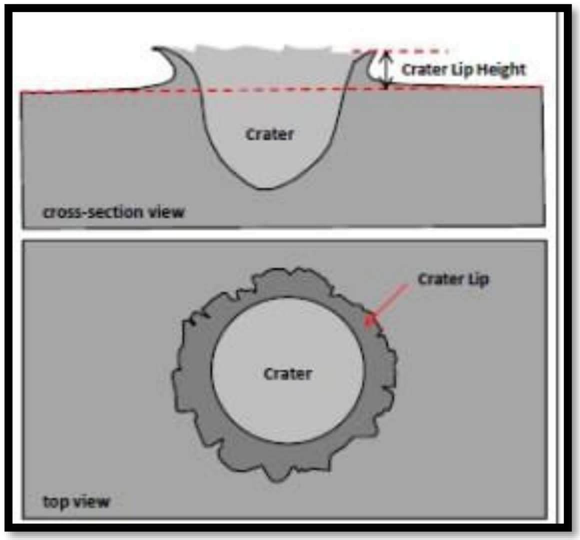


K	1.376
L	0.625
M	0.375

Dimensions in inches

Figure 2 – Picture of MMOD impact on handrail with sharp edge.





Credit: Orbital Debris Quarterly News

Figure 3 – A sharp edge can develop on one of the 3 surfaces below.

NASA Microgravity NExT

EVA Camera Attachment Mechanism

Background

Extravehicular Activities (EVAs), or spacewalks, on the International Space Station (ISS) are currently viewed through cameras mounted on the astronauts' suits. There is a desire to have another view of the EVA tasks from a separate camera that the astronauts can carry with them and attach to the ISS exterior nearby their worksite. The camera will need to be attached to a stanchion that allows for clocking and adjustability of the camera angle. Since the tasks performed on EVAs are different and take place in a different location each time, the stanchion will need the ability to attach to different interfaces. These interfaces include ISS handrails, the ISS truss segment frame, and the CETA cart square grid.

Objective

Design a stanchion and attachment mechanism to allow for a camera to be mounted to the exterior of the ISS by astronauts during EVAs.

Assumptions

- The astronaut is stabilized, has 2 free hands and can react small amounts of load.
- The device can have multiple parts that can attach and detach.

Requirements

1	The device shall attach to at least two of the three interfaces outlined in Figures 1-3 (see Test Setup section).
2	The device shall include a 2-fault tolerant attach method to each of the three interfaces.
3	The device shall be removable.
4	The device shall cause no damage (scraping, chipping, etc) to any hardware.
5	The device shall use only manual power.
6	The device shall allow for camera pitch adjustability of at least ±45° and camera yaw adjustability of at least ±45° (see Figure 4).
7	The total weight of all parts you provide should be less than 15 lbs.
8	The device/s shall be able to pack within a 12" x 16" x 18" volume.
9	The device and any removable components shall have a tether attachment point 1" in diameter.
10	All tools must be operable with EVA gloved hands (like heavy ski gloves).
11	Tools must not have holes or openings which would allow/cause entrapment of fingers.
12	Tools must be made from the NBL Approved Materials List or a waiver must be granted.
13	Lubricants must be selected from the NBL Approved Lubricant List or a waiver must be granted.
14	There shall be no sharp edges on the tool.
15	Pinch points should be minimized and labeled.
16	Tools shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool.

Test Setup

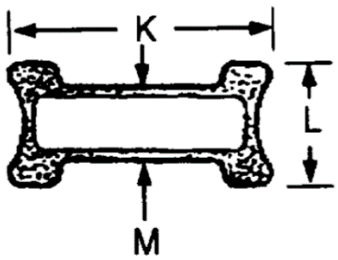
- A camera and standard GoPro waterproof housing will be provided by NASA.
    - Note: NASA will provide only a clear housing (see image below) that has a standard 2-prong GoPro interface:

Each team is responsible for providing the 3-prong interface and knob (like the black hardware at bottom of image). There are many options of attachments with the 3-prong GoPro interface available. Feel free to email us with your chosen part to verify it will interface correctly.

- The test subject will attempt to attach your device to up to three of the interfaces detailed in Figures 1-3. (Note: Proposal selection chances will increase with the number of interfaces the device can attach to.)
    - Interface 1: ISS EVA Handrail
    - Interface 2: ISS Truss Segment Frame
    - Interface 3: Square Grid of CETA Cart
- The test subject will test the camera pitch and yaw adjustability.

References

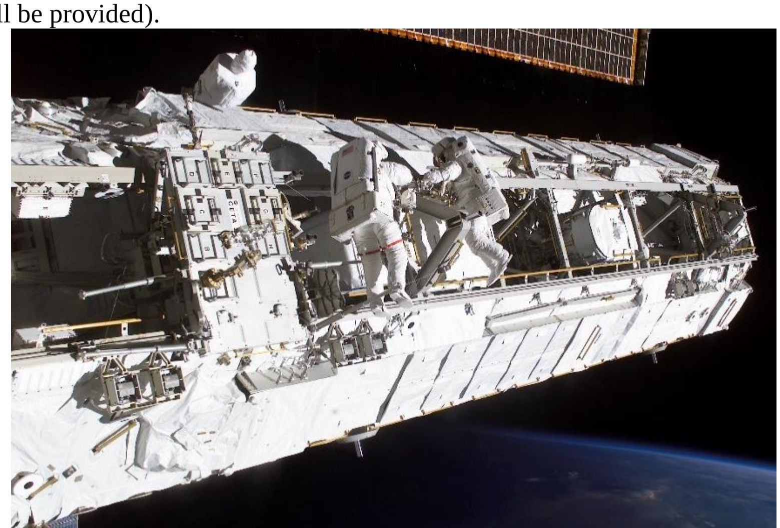
Figure 1 – Picture of ISS EVA Handrail and dimensions. Device can attach to any portion of the handrail, including the stanchions.



K	1.376
L	0.625
M	0.375

Dimensions in <u>inches</u>

Figure 2 – Picture of ISS Truss Segment and close-ups of frame. Frame is roughly 12” wide with 1/8” think edges (exact dimensions will be provided).



Device should attach around two edges of the frame

Note: The device shall be able to attach around two edges of the truss frame and not rely on access to attach all the way around the frame.

Truss Frame

Updated dimensions of truss frame cross-section:

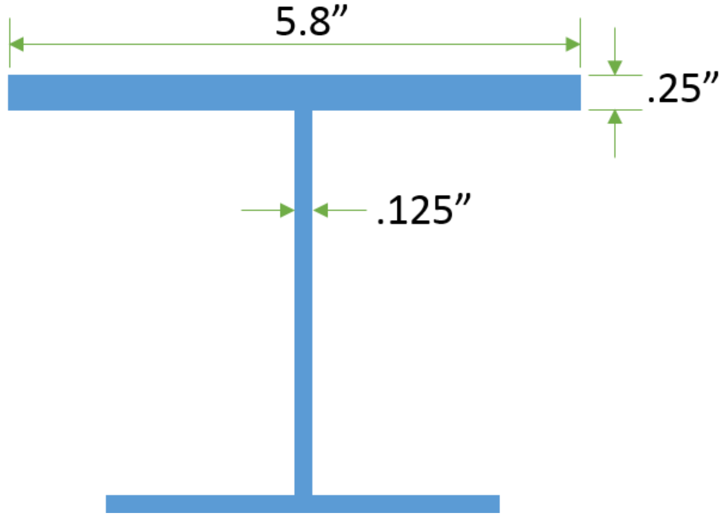
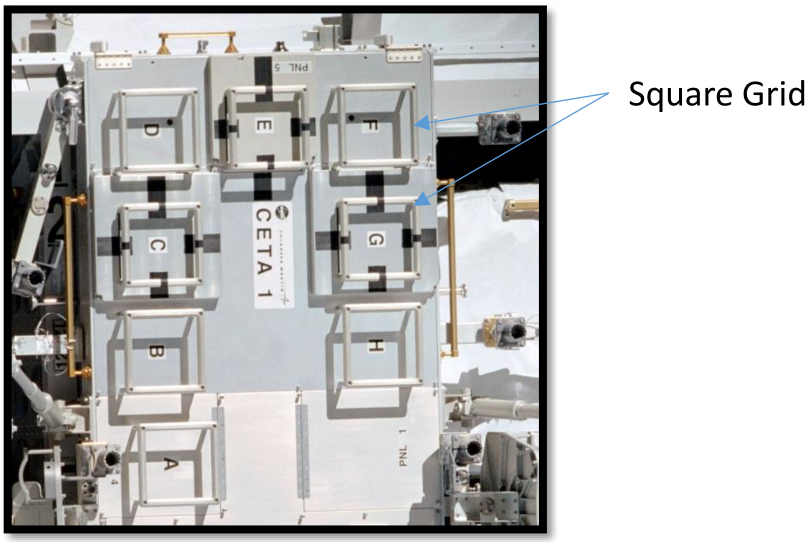
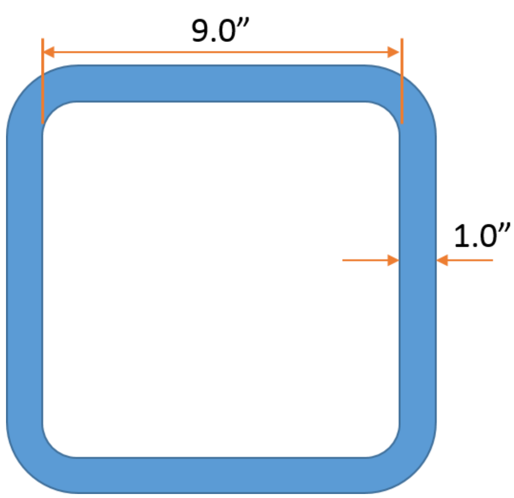


Figure 3 – Square grid of CETA Cart. CETA Cart can be pulled by crew on EVAs to worksites to aid in moving large items. Dimensions will be provided at a later date but are roughly 10” x 10” squares made of 1” square-profile rails.



Updated dimensions of square grid:
TOP:



10.12.2018

OCTAGONAL CROSS-SECTION:

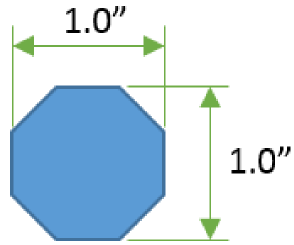
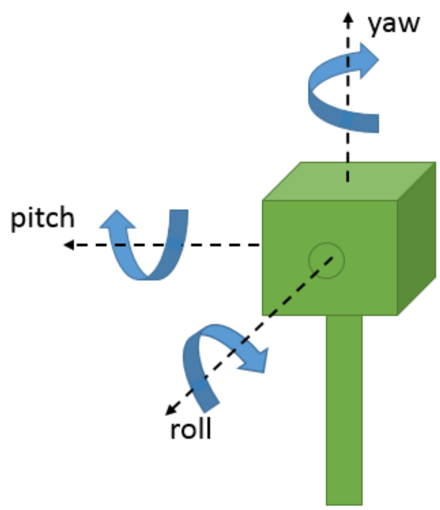


Figure 4 – Yaw, Pitch, Roll rotations.



NASA Microgravity NExT

Mini-Arm End-Effector

Background

NASA is currently working on systems to explore underneath the ice-covered surface of so-called "Ocean Worlds" such as Europa and Enceladus. These systems are required to operate underwater and sample both the surrounding water and any ice-structures. These ice-structures may potentially serve as a structure upon which microbial life could thrive. A new mini-arm has been developed for remotely operated vehicles (ROVs) to probe this environment, but end-effectors have not yet been designed. The arm is unique in that each joint is wirelessly controlled and locally powered – no wires are needed between the actuators! This allows the "links" to be custom-3D-printed per mission need.

Objective

Design and manufacture an end-effector that interfaces with the mini-arm and can manipulate ice cores and instruments in an underwater environment.

Assumptions

- The mini-arm will NOT be attached to the ROV vehicle, but on a fixed standalone platform.
- Electrical interfacing (power and signal) will be provided to the teams on the NBL deck (dry) and it will be the responsibility of the teams to run an underwater tether to their device. Interfacing the end-effector with the mini-arm wireless system is outside the scope of this challenge.

Requirements

1	The device shall be able to grasp and transfer cylindrical nylon samples, 0.5" in diameter and 3" deep, into a 6" wide by 6" long by 2" tall sample collection bin.
2	The device shall be able to grasp 1" x 1" 8020 aluminum extrusion.
3	The device shall mechanically interface with the ROV mini-arm using the provided M3x0.5, 6 mm deep tapped holes on the output plate (see Figure 2).
4	The device shall be electrically operated by no more than 12V and 3A. Power will be supplied by the NBL and teams must be able to connect to a standard banana plug connector commonly found on power supplies.
5	The device can have multiple parts that can attach and detach.
6	The device (in stowed configuration) shall fit within a 4" diameter x 5" long cylinder.
7	The device (all parts) shall operate underwater with provided electrical power.
8	The device (all parts) shall have a dry weight less than 2 lbs.
9	The device (all parts) shall be close to neutrally buoyant, with a buoyancy no more than +1 lb and no less than -1 lb.
10	The device shall be commanded via general purpose input/output lines (3.3V or 5V compatible), or via a Universal Asynchronous Receiver / Transmitter (UART – 3.3V / 5V).
11	The device shall be compatible with a chlorine water environment and a salt-water environment.
12	The device shall operate within an environment from -5 deg C to 30 deg C.

Figure 1: Mini-Arm Assembly View

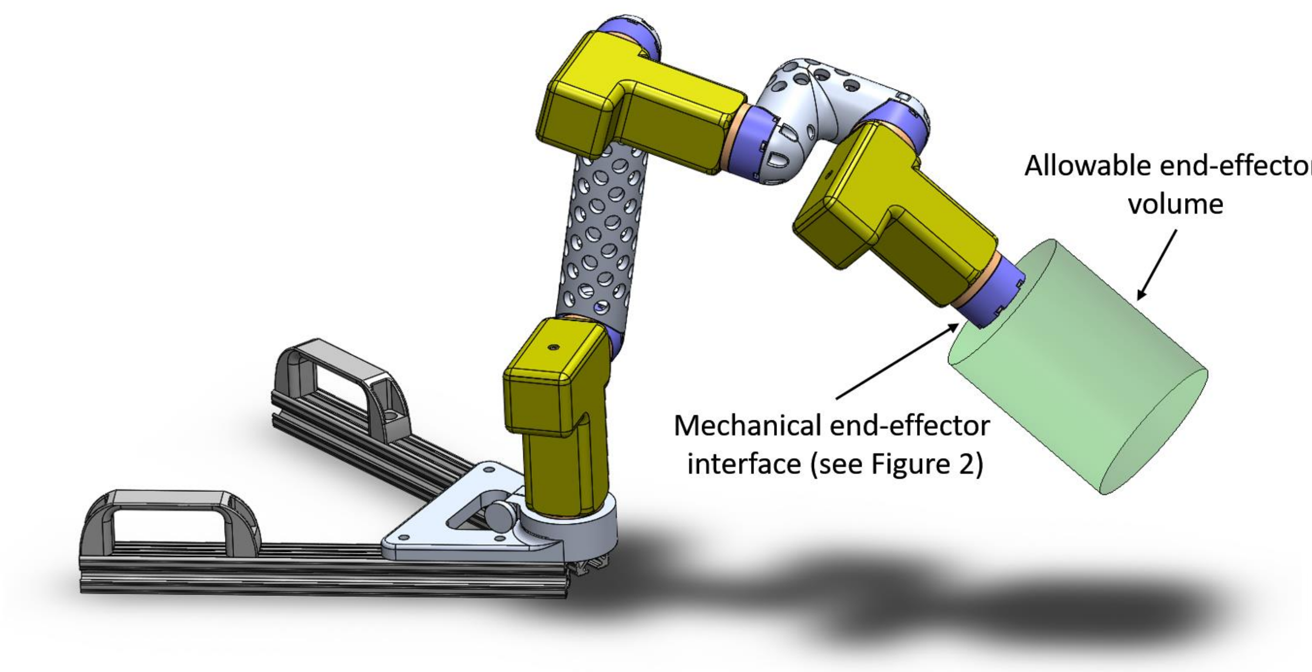


Figure 2: Mini-Arm Mechanical Interface